REMARKS

Claims 27-31 are pending. Claim 26 has been cancelled. The Claims have been amended in accordance with the suggestions of the Examiner in the outstanding Office Action as discussed below.

Specification

The Examiner objected to the specification because of the use of the terms "means" and "disclosed" in the body of the abstract. The specification has been amended herein to delete this phraseology. Consequently, the Applicants respectfully request the withdrawal of these objections to the specification.

112 Rejections

The Examiner rejected Claims 26-31 under 35 USC 112 alleging that the claim limitation "force torque vector" (m_d) is not reasonably described in the specification. The Applicants respectfully disagree as this quantity is fully defined at page 4, lines 15-19. Consequently, the Applicants respectfully request the withdrawal of the rejections made under 35 U.S.C. 112.

103 Rejections

Claim 26-28 are rejected under 35 U.S.C. 103(a) as being anticipated by Wada in view of Feng et al. and further in view of Nagaoka et al. This rejection has been obviated by the amendments made to the Claims herein. New Independent Claim 29 has been amended to include the subject matter of cancelled base Claim 26. Moreover, because independent Claim 29 includes the limitations indicated by the Examiner as being allowable and the limitations of intervening Claim 28, Claim 29 is now in condition for allowance. Claims 27, 30 and 31 have been amended to depend from Claim 29 and are therefore themselves now allowable.

Conclusion

In light of the above-listed amendments and remarks, Applicants respectfully request allowance of the remaining Claims.

The Examiner is urged to contact Applicants' undersigned representative if the Examiner believes such action would expedite resolution of the present Application.

Respectfully submitted,

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Dated: 5/23, 2003

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION

Beginning at page 37, line 2, please replace the abstract with the following:

-- A mobile robot base movable relative to a surface, comprising: at least two wheels pivotably and rotatably mounted to the base, each wheel having a steering axis and a rotation axis; a drive [means] mechanism for rotating the wheels along the surface; steering [means] mechanism for pivoting the wheels with respect to the surface; and controller means for controlling the motion of the base, wherein the controller means includes means for reading an input motion vector from a host processor, mapping the input vector to a desired axis motion vector for each of the axes (Fig. 3), calculating a control envelope for each of the axes, determining whether the axis motion vector lies within the control envelope for each of the axes (Fig. 3), calculating a modified axis motion vector when the axis motion vector does not lie within the control envelope (Fig. 3), sending the axis motion vector or modified axis motion vector to an axis controller for each of the axes (Fig. 3), estimating a motion of the base traveled during a discrete time interval delta t (Fig. 3), calculating a position and an orientation of the base in a set of world coordinates (Fig. 3), and repeating the previous steps continuously until commanded to stop (Fig. 3). Other aspects include a holonomic base capable of instantaneous movement in any direction without reconfiguring the wheel headings, regardless of the configuration of the wheels. Also, a method of using forces and torques to control the base, and to compensate for undesired motions of the base due to dynamic effects of the wheel motions is disclosed. --

CLAIMS

Please amend the following Claims as shown below:

Please cancel Claim 26.

27. (Amended) An apparatus as described in claim 29 [26] wherein the controller means includes a dynamic model such that the controller means compensates for undesired motion of the base due to various motions of the wheels.

29. (Amended) [An apparatus as described in claim 28] A mobile base movable relative to a surface, the base comprising:

a main housing;

at least two wheels pivotably and rotatably mounted to the housing, each wheel having a steering axis and a rotation axis with the steering and rotation axes nonintersecting and offset by a known caster distance;

drive means for rotating the wheels to roll along the surface;

steering means for pivoting the wheels and changing their heading with respect to the surface; and

controller means for reading an input vector from a host processor, wherein the input vector is a three dimensional force torque vector,

reading the steering axis headings,

calculating a desired torque for each steering and rotation axis such that at any given time, the calculated resultant forces on the base reflect the input vector, regardless of the positions of the steering and rotation axes, and

commanding the calculated torque to each steering and rotation axis,

wherein the calculated torque of each steering and rotation axis is computed from the input vector and a generalized inverse of a constraint matrix, C, the constraint matrix being defined by the following kinematic relationship:

$$\bar{m}_a = C\bar{m}_x$$

where $\bar{m}_a$ represents a motion axis vector and $\bar{m}_x$ represents actual mobile base motion and wherein the generalized inverse of C is chosen such that a sum of squares of the axis torques is minimized.

30. (Amended) An apparatus as described in claim 29 [28] wherein the generalized inverse of C is chosen such that a sum of squares of wheel contact forces is minimized.

31. (Amended) An apparatus as described in claim 29 [28] wherein there is an instantaneous power for each of the steering and rotation axes and wherein the generalized inverse of C is chosen such that a sum of the instantaneous powers of all of the axes is minimized.